Upper Urinary Tract Stones

Grand Rounds

Beow Kiong, Poh
Fellow Endourology

Learning Objectives

• Should we treat small, asymptomatic, uncomplicated renal stones?

• PNL, SWL, URS – Which is best for renal stones?
Why do we need answers to clinical questions?

- The Patient
- The Student
- Ourselves

Can asymptomatic uncomplicated stones be left alone?
Prospective Long-Term Follow-up of Patients With Asymptomatic Lower Pole Caliceal Stones

Kubilay Inci,* Ahmet Sahin, Ekrem Islamoglu, Murat T. Eren, Mehmet Bakkaloglu and Haluk Ozen

J Urol. Vol. 177, 2189-2192

- Asymptomatic lower calyceal stones
- Exclusion:
  1. stones in other locations
  2. Urinary tract congenital anomalies
  3. solitary kidney
  4. ↑ serum creatinine (> 2 mg/dl)
  5. obstruction
  6. diabetes and pregnancy
Evaluation

- Initial: CT KUB + IVP
- F/U: 6-monthly
- Yearly upper tract imaging: CT odd years, U/S even years
- KUB x-ray in between
- CT reconstruction: greatest and cumulative diameter (for multiple stones)
- Biochemistry and urine analysis

Disease Progression

- pain
- stone growth
- dilatation of the urinary system
- recurrent urinary tract
- infection
- persistent gross hematuria
Results

• 24 patients recruited with 27 renal units

• Mean f/u 52.3 months

• Average 3.5 CT scans/patient
Progression

- 33.3% of renal units experienced ↑ stone size
- Mean ↑ in stone size: 7.2mm
- No significant correlation between stone size at initial presentation and rate of stone growth
- 3/27 renal units (11.1%) required surgical intervention only after 2 years f/u
- No pyelonephritis/loss of life or kidney

Spontaneous passage

- 50% for stones less than 5 mm in diameter,
- 16% for stones 5 to 10 mm
- 0% for stones larger than 10 mm.
- 5 renal units (18.5%) were stone-free at the end of f/u
A Prospective, Randomized Trial of Management for Asymptomatic Lower Pole Calculi

Yuruk E, Binbay M, Sari E, Akman T, Altinay E,
Baykal M, Muslimanoğlu A, Tefekli A

- RCT- 99 pts with lower pole stone ≤20mm
- Excluded: radiolucent stone, high serum creatinine, solitary kidney, UTIs, renal anomalies, previous renal scarring and a dilated pelvicaliceal system
- 1) observe  2) PNL  3) ESWL-33 pts each
- Initial evaluation: IVP + $^{99m}$Tc-DMSA
- F/U: 3-monthly KUB x-ray + serum creat + urine c/s + single positron emission CT renal scintigraphy at 6 weeks and 12 months
- PNL + SWL grp: non-contrast CT Abd 3 and 12 months post intervention

PNL

- Open system with balloon dilation and Amplatz sheath
- All single tract
- Swiss Lithoclast® Master
- Intraoperative antegrade nephrostography
SWL

• Without anesthesia
• Compact Sigma® electromagnetic lithotriptor
• Gradual progression to 24kV, 3000 shocks/session
• Evaluation by KUB X-ray 1 week after SWL
• SWL failure = 3 sessions without stone fragmentation

Progression

• symptoms related to ureteral/caliceal obstruction
• stone growth
• recurrent urinary infections
• hematuria
### Patient demographics and stone characteristics

<table>
<thead>
<tr>
<th></th>
<th>PNL</th>
<th>SWL</th>
<th>Observation</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean ± SD age (range)</strong></td>
<td>44.1 ± 12.3 (24-77)</td>
<td>44.5 ± 9.4 (30-64)</td>
<td>44 ± 12.2 (19-70)</td>
<td>0.34 (ANOVA)</td>
</tr>
<tr>
<td><strong>Mean ± SD mm² stone area (range)</strong></td>
<td>103 ± 30 (59-314)</td>
<td>132.4 ± 85.3 (58-314)</td>
<td>136.7 ± 51.4 (88-283)</td>
<td>0.06 (Kruskal-Wallis test)</td>
</tr>
<tr>
<td>No. male/female</td>
<td>15/15</td>
<td>16/15</td>
<td>19/13</td>
<td>0.66 (chi square test)</td>
</tr>
<tr>
<td>No. rt/lt side</td>
<td>16/16</td>
<td>17/14</td>
<td>17/16</td>
<td>0.06 (chi square test)</td>
</tr>
<tr>
<td><strong>Mean ± SD mm stone followup (range)</strong></td>
<td>18.2 ± 5 (12-20)</td>
<td>20.4 ± 4 (12-20)</td>
<td>19.4 ± 5.7 (12-20)</td>
<td>0.1 (Kruskal-Wallis test)</td>
</tr>
<tr>
<td>No. stone-free/total No. (%)</td>
<td>3 Mos: 30/31 (96.7)</td>
<td>17/31 (54.8)</td>
<td>0/32</td>
<td>&lt;0.001 (chi square test)</td>
</tr>
<tr>
<td></td>
<td>12 Mos: 31/100 (31.3)</td>
<td>19/91 (63.3)</td>
<td>1/22 (3.1)</td>
<td>&lt;0.001 (chi square test)</td>
</tr>
<tr>
<td>No. renal scanning on DMSA scintigraphy (%)</td>
<td>1 (3.2)</td>
<td>5 (16.1)</td>
<td>0</td>
<td>0.05 (chi square test)</td>
</tr>
</tbody>
</table>

* Calculated according to European Association of Urology Guidelines on Urinary Tract Stones.

## Results
Observation

• 18.7% required intervention: ↑size, UTI, symptoms

• Median time to intervention 22.5 months (18 – 26 months)

• 1 patient (3.1%) had spontaneous passage

• No renal scarring

PNL

• 100% stone free in 12 months

• 1 patient (3.2%) needed transfusion

• 1 patient had post op fever

• 1 patient had lower pole scarring-no change in renal function
SWL

• 61.3% stone free in 12 months

• 1 patient (3.2%) had steinstrasse

• 1 patient had lower pole hematoma

• 5 patients (16.1%) had lower pole scarring—all had 3 sessions of SWL

More data on observation of small renal stones

<table>
<thead>
<tr>
<th></th>
<th>Progression Rates</th>
<th>Intervention rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Burgher et al</td>
<td>77%</td>
<td>26%</td>
</tr>
<tr>
<td>Keeley et al</td>
<td>*</td>
<td>21%</td>
</tr>
<tr>
<td>Inci et al</td>
<td>33.3%</td>
<td>11.1%</td>
</tr>
<tr>
<td>Glowacki et al</td>
<td>-</td>
<td>48.5%</td>
</tr>
</tbody>
</table>

*no difference in stone free rates between SWL and observation groups
No discussion if....

- ESWL/URS is 100% efficacious
- ESWL/URS is 100% safe
- ESWL/URS is FREE

But....

- Lingeman et al. followed 295 pts after ESWL. 8.2% developed hypertension within 1 year.
- William et al, followed 148 patients with ESWL. 8% developed hypertension within 17-21 months with documented decreased ERPF
- Other complications e.g. steinstrasse, UTI, hematoma
- Albala et al.: stone free rates for SWL-37%
- Keeley et al.: stone free rates for SWL-28%
URS

• Ureteral perforation
• Ureteric stricture
• Anesthesia
• Cost

Observation

• Cost of follow up
• Radiation exposure of follow up
• Anxiety
• Insurance/employment considerations
If YOU have this....

60-70% chance of not requiring intervention – take it?
How will you advise your patient?....

The surgical options
Surgical options for renal stones

- Open surgery
- SWL
- URS
- PNL
Open surgery

SWL

- Newer machines safer
- Better understanding of shockwave mechanics
- Patient selection
- Auxillary maneuvers - diuretics/position
**URS**

- Better scope optics
- Passive / active deflection
- Smaller scopes
- Access sheaths
- Improved laser delivery system/smaller baskets

**PNL**

- Improved imaging
- Balloon dilation
- Open Amplatz system
Which procedure is better?

- Big Stone
- Small Stone
Ureteroscopy and holmium laser lithotripsy with basketing of fragments.... Anyone?

PNL?
Lower pole calyceal stone
Big stone-Lower pole

- PNL came before SWL
- Early PNLs were clouded by limited experience, crude technology and complications \(^1,2\)
- Chaussy et al reported 1\textsuperscript{st} clinical data of SWL-90\%SFR\(^3\)
- Novel technology phenomenon then?


Management of lower pole nephrolithiasis: a critical analysis.
Lingeman et al J Urol, 151: 663, 1994

- Meta analysis
- SFR PNL vs. SWL (HM-3)
- PNL superior: 90\% vs. 56\%-statistically significant
- SFR in PNL is independent of initial stone burden
SFR in SWL is inversely correlated to stone burden

<table>
<thead>
<tr>
<th>Stone Sizes</th>
<th>&lt; 10mm</th>
<th>10-20mm</th>
<th>&gt;20mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>SFR</td>
<td>74%</td>
<td>56%</td>
<td>33%</td>
</tr>
</tbody>
</table>

Lingeman et al
J Urol 1994

LOWER POLE I: A PROSPECTIVE RANDOMIZED TRIAL OF EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY AND PERCUTANEOUS NEPHROLITHOTOMY FOR LOWER POLE NEPHROLITHIASIS—INITIAL RESULTS

David M. Albala, Dean G. Assimos, Ralph V. Clayman, John D. Denstedt, Michael Grasso, Jorge Gutierrez-Aceves, Robert I. Kahn, Raymond J. Leveillee, James E. Lingeman, Joseph N. Macaluso, Jr., Larry C. Munch, Stephen Y. Nakada, Robert C. Newman, Margaret S. Pearle, Glenn M. Preminger, Joel Teichman, and John R. Woods
Lower pole I: SWL vs. PNL

- Multi-centre RCT-adults with lower pole stone ≤ 3cm

**Inclusion Criteria**
- Patients older than 18 years
- Stone burden 30 mm. or less (aggregata diameter)
- Lower pole stones only
- Patients agreeable to randomization between shock wave lithotripsy and percutaneous stone removal

**Exclusion Criteria**
- Ureteropelvic junction obstruction
- Caliceal diverticulum
- Infundibular stenosis
- Shock wave lithotripsy or percutaneous stone removal contraindicated or not feasible due to body size or habitus, or coagulopathy
- Stones in renal pelvis, ureter, or mid or upper pole calices
- Renal insufficiency with serum creatinine greater than 3.0 mg.
- Cystinuria
- Transplant kidneys

Follow up

- 3 months post intervention then annually x 3 years

- Nephrotomogram

- Serum creatinine and blood pressure

- Treatment failure: treatment with a procedure other than that to which the patient was originally randomized
Results

- 128 patients enrolled
- Average stone burden equivalent in both procedures

<table>
<thead>
<tr>
<th>Table 1. Stone burden</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size (mm.)</td>
</tr>
<tr>
<td>0–10</td>
</tr>
<tr>
<td>11–20</td>
</tr>
<tr>
<td>21–30</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>

Retreatment

- re-treatment was correlated with stone size for ESWL but not PNL
- ESWL failed in 9 patients
- no treatment failures in the PNL group

<table>
<thead>
<tr>
<th>Table 2. Auxiliary procedure and re-treatment rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stone Size (mm.)</td>
</tr>
<tr>
<td>No./Total No. ESWL (%)</td>
</tr>
<tr>
<td>Re-treatment</td>
</tr>
<tr>
<td>Auxiliary procedure</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>

| No./Total No. percutaneous stone removal (%) | 522 (23) | 1323 (59) | 26 (22) |
| Re-treatment | 2 (10) | 1 (3) | 2 (25) | 5 (9) |
| Auxiliary procedure | 0 (0) | 1 (3) | 0 (0) | 1 (2) |
| Totals | 522 (10) | 1323 (6) | 26 (22) |
SFR

- SFR for PNL 95% and SWL 37% (p<0.001)

![Graph showing SFR rates](image)

Complications and hospital stay

- PNL associated with significantly longer hospital stay

![Table showing complications](image)

**TABLE 3. Complications**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESWL:</td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>1</td>
</tr>
<tr>
<td>Obstruction</td>
<td>2</td>
</tr>
<tr>
<td>Colic</td>
<td>2</td>
</tr>
<tr>
<td>Hematuria</td>
<td>1</td>
</tr>
<tr>
<td>Steinstrasse</td>
<td>1</td>
</tr>
<tr>
<td>Percutaneous stone removal:</td>
<td></td>
</tr>
<tr>
<td>Urinary tract infection</td>
<td>1</td>
</tr>
<tr>
<td>Bican</td>
<td>3</td>
</tr>
<tr>
<td>Spiess</td>
<td>1</td>
</tr>
<tr>
<td>Hematuria</td>
<td>2</td>
</tr>
<tr>
<td>Obstruction</td>
<td>1</td>
</tr>
<tr>
<td>Perforation</td>
<td>3</td>
</tr>
<tr>
<td>Transfusion</td>
<td>1</td>
</tr>
<tr>
<td>Arteriovenous fistula</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total No. (%)</strong></td>
<td>19/57 (29)*</td>
</tr>
</tbody>
</table>

* Two patients had 2 complications.
Summary of results-Lower Pole I

• For LP stones >10mm, SWL gave 33% SFR
• PNL gave >85% SFR for all LP size categories
• Retreatment: SWL vs. PNL  16% vs. 9%
• Retreatment with auxiliary procedures: SWL vs. PNL  16% vs. 2%
• For SWL, SFR is inversely related to stone size and re-treatment rates increases with stone size.

Small Stone-Lower pole
Methods

- Multi-centre RCT-adults with isolated LP stone ≤ 1cm
- Exclusion:
  1. concomitant same side non-lower pole stones,
  2. ureteral stricture or UPJO
  3. infundibular stenosis or caliceal diverticulum a/w targeted stone
  4. transplant, pelvic or solitary kidney
  5. renal insufficiency (serum creatinine >3.0 mg/dl)
  6. pregnancy
  7. previous failed treatment
  8. cystinuria
  9. urinary diversion
  10. impassible urethral stricture
  11. planned simultaneous treatment of contralateral stones
  12. active UTI
  13. immunocompromised state
i.e.

Evaluation and f/u

• Initial: CT +/- IVP

• F/U: thin cut CT KUB 3/12 after treatment

• Others: pain assessment, time to work, time to normal activity
Results

- 67 pts continue on study protocol

<table>
<thead>
<tr>
<th>Table 3: Patient and stone characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td><strong>SWL</strong></td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>Mean age ± SD</td>
</tr>
<tr>
<td>Body mass index ± SD</td>
</tr>
<tr>
<td>No. male/women</td>
</tr>
<tr>
<td>No. r/i stones</td>
</tr>
<tr>
<td>% American Society of Anesthesiologists grade:</td>
</tr>
<tr>
<td>I</td>
</tr>
<tr>
<td>II</td>
</tr>
<tr>
<td>III</td>
</tr>
<tr>
<td>Mean stone surface area ± SD (mm²)</td>
</tr>
</tbody>
</table>

Outcomes

- SWL faster
- 89% stented after URS vs. 3.1% (1/32) in SWL grp.
- URS grp: 17% had balloon pre-dilation and 69% used access sheath
- 1 SWL pt had PVCs
- 2 URS pts had ureteral perforations
- No significant difference in retreatment rates
*no diff in SFR btwn pts with fragments manually removed (58%) vs. those with fragments left behind (50%), p =1.0

*same observation for displaced stones (69%) and in situ treated stones (50%), p =0.53 (?protection of scopes)
QoL

**Table 5. Patient derived quality of life measures**

<table>
<thead>
<tr>
<th></th>
<th>SWL</th>
<th>URS</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean days to driving</td>
<td>1.9</td>
<td>5.3</td>
<td>&lt;0.001 (Mann-Whitney rank sum test)</td>
</tr>
<tr>
<td>± SD</td>
<td>1.7</td>
<td>5.1</td>
<td>0.021 (Mann-Whitney rank sum test)</td>
</tr>
<tr>
<td>Mean days to return</td>
<td>3.2</td>
<td>7.9</td>
<td>0.003 (Mann-Whitney rank sum test)</td>
</tr>
<tr>
<td>to nonstressful activity</td>
<td>3.1</td>
<td>9.8</td>
<td>0.006 (Mann-Whitney rank sum test)</td>
</tr>
</tbody>
</table>
| Mean days to return    | 3.3  | 8.5  | 0.051 (chi-square test)    | work ± SD
| Mean days until 100%   | 8.1  | 15.8 | recovered ± SD           |
| recovered ± SD         | 10.8 | 11.6 |
| % Would chose procedure | 90   | 83   |

• SWL grp required less pain pills than URS grp (5.6 vs. 14.7, p =0.015)

Summary

• SFR: URS 15% higher than SWL but not statistically significant

• Complication rates not significantly different

• QoL favours SWL
Why is SWL the common enemy?

- Outpt
- Short learning curve
- Safe-r
- Sound
- Protocols, machines, indications, results variable


Diagram: Measurement scheme for lower pole anatomy. LPL, lower pole length; LPLW, lower pole infundibular width; LPINF, lower pole infundibulo-perineal Q5R, Q, R and S waves.
Ways to make SWL better

• PID-percussion, inversion, diuretic
• Intraluminal irrigation of fluid
• “stir-up therapy”


My message

• 30% treatment chance during conservative management a small asymptomatic renal stone- but is anything lost?
• Lower pole stone >1cm, data for PNL strong-gravity will prevail
• Lower pole stone <1cm, SWL=URS - $ and QoL needs to be considered.
Proximal ureter

Matched pair analysis of ureteroscopy vs. shock wave lithotripsy for the treatment of upper ureteric calculi

*Int J Clin Pract, May 2007, 61, 5, 784–788*

G. D. Stewart, S. V. Bariol, S. A. Moussa, G. Smith, D. A. Tolley

- Retrospective data with prospective matching of subjects  SWL vs. URS
- Inclusion: adults pts with proximal ureter stone
- Exclusion: UPJ stone and prior drainage procedure
- SWL: Dornier Compact
- URS: semi-rigid/flexible with laser EHL or pneumatic
Matched data

Table 1 Patient characteristics upper ureteric stones

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lithotripsy</th>
<th>Ureteroscopy</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of matched patients</td>
<td>22</td>
<td>27</td>
<td>N/A</td>
</tr>
<tr>
<td>Mean age (SD)</td>
<td>45.8 (15.0)</td>
<td>59.4 (15.2)</td>
<td>0.004*</td>
</tr>
<tr>
<td>No. females (%)</td>
<td>6 (22.2)</td>
<td>6 (22.2)</td>
<td>N/A</td>
</tr>
<tr>
<td>No. males (%)</td>
<td>21 (77.8)</td>
<td>21 (77.8)</td>
<td>N/A</td>
</tr>
<tr>
<td>No. side (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left</td>
<td>15 (55.6)</td>
<td>15 (55.6)</td>
<td>N/A</td>
</tr>
<tr>
<td>Right</td>
<td>12 (44.4)</td>
<td>12 (44.4)</td>
<td>N/A</td>
</tr>
<tr>
<td>Mean mm stone (range)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum</td>
<td>8.2 (4.0–16.0)</td>
<td>8.0 (3.0–17.0)</td>
<td>0.759*</td>
</tr>
<tr>
<td>Minimum</td>
<td>4.6 (2.0–10.0)</td>
<td>4.8 (2.0–12.0)</td>
<td>0.965*</td>
</tr>
<tr>
<td>Stone free at 3 months (%)</td>
<td>24 (86.9)</td>
<td>22 (81.5)</td>
<td>0.625†</td>
</tr>
<tr>
<td>Success (%)</td>
<td>17 (63.0)</td>
<td>15 (55.6)</td>
<td>0.727†</td>
</tr>
<tr>
<td>Re-treatment (%)</td>
<td>7 (25.9)</td>
<td>3 (11.1)</td>
<td>0.219†</td>
</tr>
<tr>
<td>Ancillary treatment (%)</td>
<td>6 (22.2)</td>
<td>11 (40.7)</td>
<td>0.327†</td>
</tr>
<tr>
<td>Re-treatment or ancillary treatment (%)</td>
<td>10 (37.0)</td>
<td>12 (44.4)</td>
<td>0.727†</td>
</tr>
</tbody>
</table>

Efficiency quotient                     | 0.57        | 0.49         | N/A     |

*U-Mann Whitney U-test. †McNemar test. N/A, not applicable; SD, standard deviation.

Results

- Between Jan 1999 – Sept 2003, 220pts had SWL and 1259pts had URS for proximal ureteric stone
- Only 27 pairs were matched
- No statistical significance in SFR/success rates
- Sub-analysis for Holmium laser “era”-9pairs matched- “holmium:YAG laser resulted in an all round improvement in the outcome measures of ureteroscopic management”
Critique

- A study with a robust statistical model but...

- Small numbers

- Absence of critical information e.g. BMI

- Wide variety of energy sources in the URS group

Acknowledgements

- Dr Ryan Paterson, Dr Ben Chew for their insight on this subject and help in this presentation